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Proceedings of the PSARC Invertebrate Subcommittee Meeting, November 25-28, 2002

K. West
Invertebrate Subcommittee Chair

Fisheries and Oceans Canada
Pacific Scientific Advice Review Committee
Pacific Biological Station
Nanaimo, British Columbia V9T 6N7

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PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE (PSARC)
INVERTEBRATE SUBCOMMITTEE MEETING

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SUMMARY

The Pacific Scientific Advice Review Committee (PSARC) Invertebrate Subcommittee met November 25-28, 2002 at the Pacific Biological Station in Nanaimo, B.C. The Subcommittee reviewed seven working papers and three stock status reports.

Working Paper I2002-01: A Phase '0' review of the biology and fisheries potential of the marine gastropods *Astraea gibberosa, Euspira lewisii, Fusitriton oegonensis, Nucella lamellosa*, and deep water snails of the family Buccinidae

This paper presented a review of the biology and fisheries of marine gastropods and deepwater snails. As interest in the potential for the development of a fishery for marine gastropods and deepwater snails was of a general nature, and with no specific species or harvest method requested, the paper was not a traditionally focussed Phase 0 report. The Subcommittee recommended that any fishery development follow the New Emerging Fisheries Policy guidelines and a focussed phase 0 be conducted on each potential species. The poor life history information on most species in our region and the corresponding known recreational harvest and bycatch of these species was a concern to the Subcommittee and warrants further investigation.

Working Paper I2002-02: Evaluation of an intensive fishery on Dungeness Crab, *Cancer magister*, in Fraser Delta, British Columbia

This paper examined the potential effects of excessive handling of crabs in an intensive crab fishery in the Fraser River area. It addressed three specific concerns: (1) does excessive handling of sub-legal crabs reduce recruitment; (2) what is the impact of intensive fishing on yield and profit; and (3) what scientific criteria could managers use to close the fishery? The Subcommittee concluded that there is no evidence of detrimental impacts of excessive handling of sub-legal crabs on recruitment but that this may be due to the short data series. The Subcommittee recommended that the models and approaches based on Catch Per Unit Effort (CPUE) data and instar modelling as presented in this paper be used in discussions among fisheries management, science, and industry on alternative management approaches and intensive fishing problems for crabs on the B.C. coast. However, they felt each area will need to be examined individually to determine their appropriate parameter values.

Working Paper I2002-03: *Pandalus hypsinotus*, Humpback Shrimp: An assessment and management framework for directed fisheries based on results from the Drury Inlet Humpback Shrimp Research Program

This paper presented the biology of the Drury Inlet humpback shrimp population, from two research cruises, including age structure, changes in sexual condition over time, natural mortality, and fecundity. The selectivity of different fishing gear (trap

and trawl) was examined and recommendations regarding how to manage recruitment overfishing in directed humpback shrimp fisheries using a fixed exploitation rate and a fixed escapement target were provided. The Subcommittee concluded that the assessment methodologies and management options were acceptable, and must take into account gear type and location. The Subcommittee recognized that there are a number of ways to manage and assess humpback shrimp fisheries, and concurs with using an F-based target reference point for trap and trawl fisheries. In addition, fixed exploitation based on in-season CPUE estimates or spawner index can be used for trap fisheries. The Subcommittee felt that the biological parameters derived from the Drury Inlet study should be utilized to manage new and existing humpback fisheries, until area-specific data can be collected.

Working Paper I2002-04: Sea Cucumber quotas based on British Columbia survey data

This paper provides the survey results and density estimates, from seven dive surveys conducted since 1998. Survey results showed that the lower 90%CI of density estimates is higher than the baseline density of 2.5 c/m-sh. The parameters and procedures used to calculate the quotas are documented and mean weights are reevaluated for all open areas using the market sampling data. The Subcommittee recommended that the open Pacific Fisheries Management Areas (PFMAs) should be grouped into three categories – surveyed, unsurveyed good habitat, and unsurveyed areas of concern (suspected poor habitat or over harvested) - to assign density estimates. For the surveyed areas, the lower 90% CI of density from the survey is recommended. For the unsurveyed areas with good habitat, the new baseline density estimate of 5.08 sea cucumbers per metre of shoreline (c/m-sh) is recommended. For the third category, unsurveyed areas with exposed shoreline or a history of low stock abundance, the original density estimate of 2.5 c/m-sh would be kept. The Subcommittee also recommended research into the appropriateness of using area versus shoreline length in quota calculations for sea cucumbers.

Working Paper I2002-05: Geoduck stock assessment framework in British Columbia

The paper presents a review of the current approaches to the assessment of geoducks in the Pacific Region. It evaluates the uncertainties in the key components of the present approach, and recommends improvements and changes where necessary. The Subcommittee noted that there are some areas of the coast that have large discrepancies in the estimated biomass compared to the biomass perceived by the industry. These areas should be priorities for re-assessment/survey, and may help to understand the uncertainties and assumptions in the present process. The Subcommittee noted that the lower 10% error in area has been confirmed by the analysis for the North Coast. However, for the South Coast, the anecdotal information suggests the uncertainty is much larger and the error maybe greater than 10%. The Subcommittee recommended that a high priority

be put on resolving inaccuracies in bed area estimates. The Subcommittee also felt that any future assessment frameworks should take into account factors that include minimal densities, oceanography, recruitment and mortality factors such as sea otter predation.

Working Paper I2002-06: Survey protocol for removal of allowable numbers of northern abalone, *Haliotis kamtschatkana*, from areas in British Columbia for use as broodstock in aquaculture

This paper reviews the data collected during 6 surveys conducted for abalone broodstock purposes and proposes survey protocol and broodstock removal considerations. The Subcommittee recommended acceptance of the protocol and recommendations developed in the paper. The Subcommittee accepted the 90% CI and continued use of a 1% harvest rate. The Subcommittee felt that if a more precautionary approach was required, the 1% harvest rate should be lowered. The Subcommittee recognized that the current abalone culture facilities are in the developmental stage wherein culture techniques are still being refined. Consideration of genetics, disease and productivity should be incorporated into the overall program.

Working Paper I2002-07: A review of the biology of opal squid *(Loligo opalescens* Berry), and of selected loliginid fisheries

This paper provided information on the taxonomy, description, distribution, life history, age and growth, reproduction, trophic relations, parasites and disease, population structure and dynamics of opal squid. Loliginid squid fisheries in California, Oregon, Washington and British Columbia were reviewed, including the effort, landing, assessment and management where information was available. Similar species in the N. E. Atlantic and Chokka squid, *L. vulgaris reynaudii,* harvested in South Africa were also reviewed. The Subcommittee recommended that any development of B.C. opal squid fisheries occur within the context of the New Emerging Fisheries Policy. Any expansion should be through a phased development of the fishery dependent on development of essential fisheries information and assessment and management frameworks. The Subcommittee also felt that the ecosystem impacts of development of B.C. opal squid fisheries be investigated given the implications concerning this species as a forage species.

SOMMAIRE

Le sous-comité des invertébrés du Comité d'examen des évaluations scientifiques du Pacifique (CEESP) s'est réuni à la Station biologique du Pacifique, à Nanaimo, en Colombie-Britannique, du 25 au 28 novembre 2002 pour passer en revue sept documents de travail et trois rapports sur l'état des stocks.

Document de travail I2002-01 : Examen de phase 0 de la biologie et du potentiel halieutique des gastropodes marins *Astraea gibberosa, Euspira lewisii, Fusitriton oegonensis* et *Nucella lamellosa*, et de buccins benthiques de la famille Buccinidae

Sont passés en revue dans ce document la biologie et le potentiel halieutique de gastropodes marins et de buccins benthiques. Comme l'intérêt dans le potentiel de développement d'une pêche de gastropodes marins et de buccins benthiques est de nature générale et aucune espèce ou méthode de récolte particulière n'est mise en cause, le document n'est pas un rapport de phase 0 régulier. Le sous-comité recommande que le développement de toute pêche se fasse conformément aux lignes directrices de la Politique pour les pêches nouvelles et qu'un examen ciblé de phase 0 soit effectué pour chaque espèce présentant un potentiel halieutique. Le peu de données disponibles sur le cycle vital de la plupart des espèces retrouvées dans la région, ainsi que sur les prises récréatives et les prises accessoires, préoccupe le sous-comité, qui est d'avis que d'autres études sont requises.

Document de travail I2002-02 : Évaluation d'une pêche intensive du crabe dormeur, *Cancer magister*, dans le delta du Fraser, en Colombie-Britannique

Sont examinés dans ce document les effets potentiels de la manutention excessive du crabe dormeur lors de la pêche intensive de l'espèce qui est pratiquée dans le delta du Fraser. Trois questions sont abordées, à savoir : (1) si la manutention excessive des crabes de taille non réglementaire réduit le recrutement; (2) quel est l'impact de la pêche intensive sur le rendement et le profit et (3) quels critères scientifiques les gestionnaires pourraient utiliser pour fermer la pêche. Le sous-comité conclut que rien n'indique que la manutention excessive des crabes de taille non réglementaire a des effets adverses sur le recrutement, mais que cela peut être imputable à la courte série de données disponible. Il recommande que les gestionnaires des pêches, les scientifiques et les intervenants de l'industrie se servent des modèles et des approches reposant sur des données sur les prises par unité d'effort (PUE) et la modélisation des stades larvaires, tels que présentés dans le document, lors des discussions portant sur d'autres approches de gestion et les problèmes inhérents à une pêche intensive du crabe dans les eaux de la Colombie-Britannique. Par contre, le sous-comité est d'avis que chaque zone de pêche doit faire l'objet d'un examen indépendant afin de déterminer les valeurs de paramètre appropriées.

Document de travail I2002-03 : Évaluation de la crevette à front rayé, *Pandalus hypsinotus*, et cadre de gestion pour la pêche dirigée reposant sur les résultats du Programme de recherche sur la crevette à front rayé de l'inlet Drury

Sont présentées dans ce document des données sur la biologie de la population de crevette à front rayé de l'inlet Drury recueillies dans le cadre de deux croisières de recherche, y compris la structure par âge, les changements dans la proportion des sexes au fil du temps, la mortalité naturelle et la fécondité. Est aussi examinée la

sélectivité de divers engins de pêche (casier et chalut) et sont ensuite présentées des recommandations pour la gestion de la surpêche du potentiel reproducteur lors des pêches dirigées de l'espèce reposant sur un taux d'exploitation fixe et une cible d'échappement fixe. Le sous-comité conclut que les méthodes d'évaluation et les options de gestion sont acceptables et doivent prendre en compte le type d'engin et le lieu de pêche. Il reconnaît qu'il existe divers moyens de gérer et d'évaluer les pêches de la crevette à front rayé et approuve l'utilisation d'un point de référence cible reposant sur F pour les pêches au casier et au chalut. Il considère aussi qu'un taux d'exploitation fixe reposant sur des estimations des PUE faites en saison ou un indice de l'abondance des reproducteurs peut être utilisé pour la gestion des pêches au casier. Le sous-comité est d'avis que les paramètres biologiques provenant de l'étude de l'inlet Drury devraient servir à la gestion des pêches existantes et nouvelles de la crevette à front rayé jusqu'à ce que des données sur chaque pêcherie soient recueillies.

Document de travail I2002-04 : Quotas d'holothurie reposant sur des données de relevé recueillies en Colombie-Britannique

Sont présentés dans ce document les résultats et les estimations de densité provenant de sept relevés en plongée effectués depuis 1998. Les résultats de relevé ont révélé que le plus faible intervalle de confiance à 90 % des estimations de la densité était plus élevé que la densité de référence de 2,5 holothuries par mètre de rivage. Les paramètres et les procédures servant au calcul des quotas sont documentés et les poids moyens pour toutes les zones ouvertes sont réévalués en regard des données d'échantillonnage du marché. Le sous-comité recommande que les secteurs d'exploitation des pêcheries du Pacifique soient groupés en trois catégories – secteurs relevés, secteurs à habitat adéquat non relevés et secteurs préoccupants non relevés (surexploités ou à habitat présumé inadéquat) - pour assigner des estimations de la densité. Dans le cas des secteurs relevés, le sous-comité recommande d'utiliser la plus faible densité à un intervalle de confiance à 90 %; dans le cas des secteurs non relevés à habitat adéquat, la nouvelle estimation de référence de la densité de 5,08 holothuries par mètre de rivage et dans le cas des secteurs non relevés à rivage exposé ou ayant une histoire de faible abondance, la première estimation de la densité de 2,5 holothuries par mètre de rivage. Le sous-comité recommande en outre que des recherches soient menées sur la pertinence de l'utilisation du secteur par opposition à la longueur du rivage dans le calcul des quotas d'holothuries.

Document de travail I2002-05 : Cadre d'évaluation des stocks de panope de la Colombie-Britannique

Sont passées en revue dans ce document les approches actuelles à l'évaluation de la panope dans la Région du Pacifique, sont évaluées les incertitudes entourant les éléments clés de l'approche actuelle et sont recommandés des changements et des améliorations lorsque nécessaires. Le sous-comité prend note des grands écarts entre la biomasse estimative et la biomasse perçue par l'industrie dans certains

secteurs de la côte. La réévaluation ou le relevé de ces secteurs devrait être une priorité, ce qui permettra peut-être de comprendre les incertitudes et les hypothèses du processus actuel. Le sous-comité remarque que l'analyse pour la côte nord a confirmé la marge d'erreur de 10 % dans la superficie. Par contre, dans le cas de la côte sud, l'information anecdotique donne à penser que le niveau d'incertitude est beaucoup plus élevé et que la marge d'erreur pourrait être supérieure à 10 %. Le sous-comité recommande que l'on donne une haute priorité à la résolution des erreurs de précision dans les estimations de la superficie des gisements. Il est en outre d'avis que tout cadre d'évaluation future devrait tenir compte de certains facteurs, dont les densités minimales, les facteurs océanographiques, le recrutement et les causes de mortalité, comme la prédation exercée par la loutre de mer.

Document de travail I2002-06 : Protocole de relevé pour le prélèvement d'un nombre autorisé d'ormeau nordique, *Haliotis kamtschatkana*, dans les eaux de la Colombie-Britannique aux fins d'établissement de stocks de géniteurs de culture

Sont passées en revue dans ce document les données recueillies lors de six relevés effectués aux fins de prélèvement d'ormeaux reproducteurs et sont proposés un protocole de relevé et des recommandations relatives au prélèvement de reproducteurs. Le sous-comité recommande que le protocole et les recommandations soient approuvés, entérine l'intervalle de confiance à 90 % et accepte que le prélèvement continue à se faire à un taux de 1 %. Il est d'avis que si une approche plus prudente était requise, ce taux devrait être réduit. Il reconnaît en outre que les installations de culture de l'ormeau existantes sont au stade de développement, les méthode de culture étant en voie d'être mises au point. Le programme devrait tenir compte de la génétique, des maladies et de la productivité.

Document de travail I2002-07 : Examen de la biologie du calmar opale *(Loligo opalescens* Berry) et de quelques pêches de Loliginidae

Sont présentées dans ce document des renseignements sur la taxinomie, la description, la distribution, le cycle vital, l'âge, la croissance, la reproduction, les relations trophiques, les parasites et les maladies, ainsi que sur la structure et la dynamique des populations de calmar opale. Sont ensuite passées en revue les pêches du calmar de la famille des Loliginidae pratiquées en Californie, en Oregon, dans l'État de Washington et en Colombie-Britannique, y compris l'effort, les débarquements, les évaluations et la gestion lorsque des données étaient disponibles, ainsi que des espèces semblables de l'Atlantique Nord-Est et le calmar chokka, *L. vulgaris reynaudii,* pêché en Afrique du Sud. Le sous-comité recommande que tout développement de la pêche du calmar opale en Colombie-Britannique se fasse dans le contexte de la Politique pour les nouvelles pêches, c'est-à-dire qu'il soit échelonné en fonction de l'élaboration de l'information essentielle sur les pêches et de cadres d'évaluation et de gestion. Le sous-comité est en outre d'avis que les effets sur l'écosystème du développement de pêches du calmar opale dans les eaux

de la province soient étudiés étant donné les répercussions qu'elles pourraient avoir sur cette espèce fourrage.

INTRODUCTION

The PSARC Invertebrate Subcommittee met November 25-28, at the Pacific Biological Station in Nanaimo, British Columbia. An external participant from Pacific Rim National Park attended the meeting and observers from Heiltsuk Fisheries, Pacific Coast Shrimpers Cooperative, Underwater Harvesters Association, Pro Quota Group, Cowichan Tribes, Penelakut Tribes, TNBC Consulting, and Pacific Sea Cucumber Harvesters Association also attended the meeting. The Subcommittee Chair, K. West, opened the meeting by welcoming the participants. During the introductory remarks the objectives of the meeting were reviewed, and the Subcommittee accepted the meeting agenda.

The Subcommittee reviewed seven Working Papers. Summaries of the Working Papers are in Appendix 1. The meeting agenda appears as Appendix 2. A list of meeting participants, observers and reviewers is included as Appendix 3.

General Subcommittee Discussion and Concerns

The issue of correct mapping of Pacific Fisheries Management Area (PFMA) boundaries onto the new electronic Canadian Hydrographic Service (CHS) charts was noted by the Subcommittee. The Subcommittee felt that this issue was a region wide one and recommended that the resources required to place the PFMA boundaries onto the new electronic CHS charts be provided by Region.

DETAILED COMMENTS FROM THE REVIEWS

I2002-01: A Phase '0' review of the biology and fisheries potential of the marine gastropods *Astraea gibberosa, Euspira lewisii, Fusitriton oegonensis, Nucella lamellosa*, and deep water snails of the family Buccinidae

K.E. Charles and R.M. Harbo **Accepted pending major revisions

Rapporteur: Ray Lauzier

This paper was a Phase 0 paper to provide a summary of the biological, ecological and fisheries potential of marine gastropods and deep water snails in the Pacific Region. There was agreement among reviewers and the Subcommittee that this paper demonstrates a good effort to gather a great deal of material together, with an extensive bibliography and a section on Aboriginal knowledge. However, both the reviewers and the Subcommittee agreed that in its present draft form, this manuscript lacked a cohesive structure, synthesis and assimilation of information into focussed conclusions or recommendations. There is a great deal of critical editing that is

required to bring this manuscript up to acceptable research document standards. Given the wide range of species and information types, sound structure for this document is crucial.

The authors commented that there was no concrete proposal for a particular species or a particular harvest method, therefore this is not a traditionally focussed Phase 0 paper. It was meant to be a background document in anticipation of requests from interested stakeholders.

The Subcommittee agreed that the scientific research required on these animals includes: basic biology, critical spawning densities, critical densities for juvenile recruitment and ecosystem impacts. Required stock assessment studies include: population distribution, abundance estimates, size at age at sexual maturity, and spawning times and locations.

Further considerations should include: aboriginal use, potential impacts on abalone, toxicity and recreational use. Management considerations could include: stewardship incentives, licence limitation, area licensing, individual quotas, closed areas, and refuge areas.

It was recognized with the poor life history information on most species in our region and the proponent-pays aspect of the new and emerging fisheries guidelines means that there will be high costs of gathering sufficient data, to be borne by industry and/or government, for fishery development. These species appear to be marginal for developing responsible/sustainable fisheries as the cost of acquiring an adequate information base could be daunting and may outweigh economic benefits. Still, this Phase 0 provides good background information on the species and reveals the challenges ahead.

The question was asked whether there are obvious next steps, and whether there are outstanding issues that could be emphasized for further development. It was considered to be extremely difficult to amalgamate this group of species and treat as a single entity. The Subcommittee agreed that major revisions were required, including clear recommendations in the paper.

The Subcommittee recognized that there is presently a recreational fishery for Moon Snails. There is also the issue of bycatch of various species in other West Coast fisheries, such as the prawn and crab fisheries. In other countries, snails and whelks are caught exclusively as bycatch, and then landed commercially.

Conclusions

There are major gaps in biological information for these species. Some of the species have been shown to be vulnerable to over-fishing in other jurisdictions.

The Subcommittee recognized that the New Emerging Fisheries Policy guidelines in the Pacific Region should be followed. Species specific reviews should be conducted prior to fisheries development. The Subcommittee had specific concerns with possible impacts of the recreational fishery on moon snails in B.C.

Recommendations

The Subcommittee accepted this paper pending major revisions to be re-reviewed by the original reviewers and the Subcommittee Chair.

1. The Subcommittee recommended that the species should be examined on an individual basis, and that any fishery be developed under the New Emerging Fisheries Policy guidelines.

2. The Subcommittee recommended that the recreational moon snail fishery needs to be examined with respect to its fishery impacts and the potential public health concerns considering the ability of this species to generate a toxin.

3. The Subcommittee recommended that by-catch issues in on-going commercial fisheries (i.e. prawn, crab) need to be examined.

I2002-02: Evaluation of an intensive fishery on Dungeness Crab, *Cancer magister*, in Fraser Delta, British Columbia

Z. Zhang, W. Hajas, A. Phillips, D. Rutherford, K. Fong **Accepted subject to revisions**

Rapporteur: Ian Perry

This paper examined the potential effects of excessive handling of crabs in an intensive crab fishery in the Fraser River area. It addressed three specific concerns: (1) does excessive handling of sub-legal crabs reduce recruitment; (2) what is the impact of intensive fishing on yield and profit; and (3) what scientific criteria could managers use to close the fishery?

One reviewer noted that the ratio of caught sub-legal males and females to legal males, and in-season CPUE data, may change from year to year and stock to stock, therefore weekly in-season and multiple-year CPUE data should be collected and analyzed before using as a sole criteria to close a fishery. The second reviewer believed that the first objective, to determine whether the reproductive capacity of crab stocks is affected by an intense fishery, has largely not been achieved. Extensive exploration of longer time series of catch and survey data using a more realistic, and more complex, population reconstruction model is needed to achieve this objective. In addition, this reviewer felt that the per-recruit analyses are inadequate because the assumption of constant recruitment is inappropriate, and a stationary per-recruit analysis is incapable of capturing the long-term effects of high

fishing pressure. The instar-based approach also suffers many of the same inadequacies as the CPUE-based approach. A more comprehensive length-based population dynamics model should be developed to assess stock status and perform stochastic simulations.

The Subcommittee accepted the authors' replies to the reviewers' comments. In particular the authors responded that the study used the only data available - waiting for more data would delay providing advice; and that more complex models are not necessarily "better" and may have even greater data requirements than the simpler models used in this study. The Subcommittee noted that this was a first analysis which could be improved once more data are available. The data are sufficient, however, to construct yield per recruit models and to estimate $F_{0.1}$ reference points to identify potential effects of frequent handling on future yields from this stock. The paper would benefit from a comparison of the CPUE-based and instar modeling approaches to estimate the handling impacts. The models developed in this paper may not be able to identify the number of crabs to be gained next year by reducing excessive handling this year, but they can identify when continued fishing this year will begin to impact next year's harvest – this is the basis for the 70% limit determined by the $F_{0.1}$ reference point.

Conclusions

There is no significant evidence of a decline in sub-legal crab recruitment in the Fraser River delta. The lack of evidence may be due to the short data series available.

There is evidence that excessive handling of sub-legal crabs can reduce future yields and reduce future profits in the fishery in the Fraser River area. Methods to reduce handling include reducing the overall exploitation rate (for example to 65-75% from the present >90% of legal-sized males in the Fraser River area) and/or to determine a critical ratio of under-sized to legal sized crabs in the catch beyond which fishing would stop. Reducing exploitation, to a rate similar to an $F_{0.1}$ reference point, has been used with other species to protect against recruitment overfishing. Such approaches would represent important changes in management actions requiring the collection of data on exploitation rates and discard ratios in-season, e.g. an on-grounds monitor program. Other measures could also be considered to reduce negative impacts of handling, such as longer soak times, larger escape rings, and/or adjustments to the length of the fishing season. The Subcommittee felt that an approach using ratios of retained to undersize crabs should be broadly applicable to regions beyond the Fraser River with intensive crab fisheries, although "critical ratios" may need to be determined by areas depending on handling mortality and other parameters.

Recommendations

The Subcommittee accepted the paper subject to revision;

1. The Subcommittee recommended that the models and approaches based on CPUE data and instar modelling as presented in this paper be used in discussions among fisheries management, science, and industry on alternative management approaches and intensive fishing problems for crabs on the B.C. coast. However, each area will need to be examined to determine their appropriate parameter values.

I2002-03: *Pandalus hypsinotus*, Humpback shrimp: An assessment and management framework for directed fisheries based on results from the Drury Inlet Humpback Shrimp Research Program

J.S. Dunham, J.A. Boutillier, D. Rutherford, K. Fong **Accepted subject to revision**

Rapporteur: Beth Bornhold

The purpose of this paper was to begin development of an assessment and management framework for directed fisheries on Humpback Shrimp. The Subcommittee agreed that the recommendations in the paper should be more focused. There are three main management options, each requiring different types of assessment, which should be more clearly defined in the text, 1) Fixed exploitation (quota), using fishery independent information, 2) Fixed exploitation using CPUE from fishery dependent information, and 3) fixed escapement, for example a spawner index. The first is applicable for use in both trap and trawl fisheries, while the other two are only applicable for use in trap fisheries. One of the reviewers noted that the recommendations could be better presented in stepwise statements or in a flow chart of decision rules depending on type of gear being fished and area where the fishery takes place. The authors agreed that some further clarification of the recommendations was required.

The Subcommittee discussed applying the Drury Inlet findings to existing humpback fishery areas, until area specific data are collected. The biological parameters measured in Drury Inlet would be a useful starting point as the assessment was conservative, and the parameters identified are within the range identified for shrimp trawl in other areas of B.C. The Subcommittee recognized that care should be taken when applying the results in other areas.

Conclusions

The Subcommittee recognized that utilizing historical logbook data, with criteria such as a minimum catch (in this case >1000 kg) and dominant species (humpbacks greatest % of catch), is appropriate for determining areas of directed humpback fisheries. Other sources of information are also available and should be explored.

The Subcommittee recognized that there are a number of ways to manage and assess humpback shrimp fisheries, and concurred with using an F-based target

reference point for trap and trawl fisheries. In addition, fixed exploitation based on in-season CPUE estimates or spawner index can be used for trap fisheries.

The biological parameters derived from the Drury Inlet study should be utilized to manage new and existing humpback fisheries, until area-specific data can be collected.

The Subcommittee concluded that the assessment methodologies and management options are acceptable, and must take into account gear type and location.

The Subcommittee recognized that the by-catch from trawl gear was greater and more diverse than from trap gear in Drury Inlet, however it should be noted that quantity and diversity of by-catch is area and gear specific.

The Subcommittee recognized that surveys designed to assess shrimp biomass should be done using trawl and trap gear.

The trap gear was more selective for large shrimp compared with trawl gear. This is an important consideration while assessing growth over fishing or measuring the impact of the fishery on the population structure.

Recommendations

The Subcommittee recommended that the paper be accepted subject to revisions.

1. The Subcommittee recommended that the framework proposed for the assessment and management of a humpback shrimp fishery be accepted.

2. The Subcommittee recommended that the proposed framework be applied to any new or existing areas of directed humpback shrimp fisheries.

3. The Subcommittee recommended that area-specific biological parameters be collected as per the proposed methodologies and framework. The biological parameters from Drury Inlet should be used, while area-specific data are collected.

I2002-04: Sea Cucumber quotas based on British Columbia survey data

S. Campagna and C. Hand **Accepted subject to revisions**

Rapporteur: Russell Mylchreest

The authors describe the survey methodologies and results, and the analytical techniques used to calculate quotas for the giant red sea cucumber *Parastichopus californicus*. The paper is a good start to improve the initial assumptions in adaptive management. With some clarification this paper will be a useful documentation of recommendations and concerns regarding the sea cucumber fishery.

Discussion occurred on the concept of surveying all areas open to harvest vs the benefits of re-surveying areas to assess fishery impacts. The authors pointed out that there are limited resources and therefore a need for an assessment framework to define the priorities for survey activities. Consideration should be given to conducting regular surveys in experimental areas. This would help evaluate trends in the areas open to the fishery.

The estimation of mean sea cucumber weight was discussed and it was agreed that further investigation should compare weights from surveys and weights from market samples to determine if there are significant differences. Also sampling methods employed by port validators should be reviewed to address possible biases in sampling.

One reviewer's suggestion of calculating true density (number of animals per area) instead of number of animals per metre of shoreline was discussed and it was agreed that such investigation should be pursued before effort is put into a re-calculation of shoreline length from digital CHS charts. The use of mean cucumber density (per m^2) data might be used to evaluate density needs for successful spawning and possibly used as a threshold for commercial fishing. Any changes to stock assessments using this new method would be reviewed by PSARC. The possibility of using logbook and CPUE information to help extrapolate densities to unsurveyed areas should be investigated.

Conclusions

The Subcommittee felt that exploration of alternative calculations of density might be worthwhile. For example, the density data would allow a calculation of true density (cucumbers per m^2) and an estimate of area might be developed with area measurements.

The new baseline density of 5.08 c/m-shoreline is regarded as conservative, but the rationale for application to unsurveyed areas should be expanded.

The Subcommittee felt that the potential biases in utilizing the market weights vs. survey weights, need to be investigated.

It was noted by the Subcommittee that the new digitized CHS charts now utilized in a number of fisheries still require the PFMA boundaries to be correctly mapped on them.

Recommendations

The Subcommittee accepted the paper with revisions.

1. The Subcommittee recommended that open PFMA's should be grouped into three categories – surveyed, unsurveyed good habitat, and unsurveyed areas of concern (suspected poor habitat or over harvested) - to assign density estimates. The lower 90% CI of density from the survey is recommended for surveyed areas. The new baseline density estimate of 5.08 sea cucumbers per metre of shoreline (c/m-sh) is recommended for unsurveyed areas with good habitat. The original density estimates of 2.5 c/m-sh. is recommended for unsurveyed areas of concern.

2. The Subcommittee recommended removal of shoreline from obvious closed or un-fishable areas (e.g. conservation areas, lagoons, other closures) from shoreline calculations.

3. To prevent localized overharvesting, the Subcommittee recommended assigning and managing quotas at the finest possible geographic scale.

4. The Subcommittee recommended that research is required on the appropriateness of using area vs. shoreline length in quota calculations.

5. The Subcommittee recommended that PFMA boundaries need to be correctly mapped to new digitized CHS charts.

6. The Subcommittee recommended that the potential biases in the mean weight estimates need to be examined, including comparison of the weights from dive surveys and the commercial harvest sampling programs be investigated prior to setting quota options for the 2003 fishery.

I2002-05: Geoduck stock assessment framework in British Columbia

C.M. Hand **Accepted subject to revisions**

Rapporteur: Guy Parker

This paper reviews the current stock assessment approach for geoducks in the Department's Pacific Region. The paper discusses the present assessment approach, and the associated uncertainties.

The Subcommittee discussed some shortfalls and issues not considered in the paper. Some areas of the coast have large discrepancies between estimated biomass and the biomass as perceived by the industry (especially on the west coast of Vancouver Island and Inside south coast waters). As well, the predation mortality by the expanding populations of sea otters is unassessed but reported to be significant, again particularly on the WCVI. Therefore, the safety nets in place are less of a reassurance and this may lead to the necessity for more conservative management.

There was also discussion on size selectivity and whether there was harvest preference in the fishery for larger animals.

Conclusions

The Subcommittee noted that an assessment framework is a work in progress and that this paper is intended as the first step. There are some areas of the coast that have large discrepancies in the estimated biomass and the biomass perceived by the industry. These areas should be priorities for re-assessment/survey, and may help to understand the uncertainties and assumptions in the present process.

The Subcommittee noted that the practice of extrapolating densities to other unsurveyed beds for quota calculation is based presently on proximity, and that other approaches based on individual bed properties should be investigated. The Subcommittee also felt that the show factors may not be necessary for some areas of the coast and that further work will be required to assess their value.

It was noted that there had been a shift in fishing harvest effort and licences to the North Coast region in recent years. North Coast areas have been fished slightly higher than the mean quota option to accommodate the re-allocation of licences from the West Coast. This reflects a greater confidence in North Coast biomass estimates. The Subcommittee noted that the lower 10% error in area has been confirmed by the analysis for the North Coast by onsite analysis. However, for the South Coast the anecdotal information suggests the uncertainty is much greater and the error may be much greater than 10%.

The Subcommittee felt that future biomass estimates in some areas of the coast need to incorporate sea otter impacts. It was noted that this framework does not apply to areas impacted by sea otters.

Recommendations

The Subcommittee accepted the paper subject to minor revisions.

1. The Subcommittee recommended putting a high priority on resolving inaccuracies in bed area estimates.

2. The Subcommittee recommended discontinuing the use of a positive error on bed area estimates until further review.

3. The Subcommittee recommended reviewing the use of show factor plots to correct survey density estimates.

4. The Subcommittee recommended investigating the issue of size selectivity in the fishery as it relates to bias in mean individual geoduck weight estimates.

5. The Subcommittee recommended re-examining parameter estimates for yield models to determine more site specific exploitation rates.

6. The Subcommittee recommended continuing to work towards other approaches based on individual bed properties for extrapolating density estimates on geoduck beds.

7. The Subcommittee recommended considering areas of concern, regarding over-exploitation or large discrepancies in the assessments, for future study and surveys.

8. The Subcommittee recommended taking into account in future assessment frameworks, factors that include minimal densities, oceanography, recruitment and mortality factors such as sea otter predation.

I2002-06: Survey protocol for the removal of allowable numbers of northern abalone, *Haliotis kamtschatkana,* from areas in British Columbia for use as broodstock in aquaculture

J. Lessard, A. Campbell, W. Hajas **Accepted subject to revisions**

Rapporteur: Erin Wylie

The paper provides a precautionary framework and protocols to collect and return abalone, from areas of B.C., for use as broodstock in aquaculture. The Subcommittee discussed the use of minimum distance between sites to prevent removals targeting on abalone aggregations in one area and felt that DFO should approve site selection and transect locations.

The Subcommittee recognized that the 90% CI of density estimates was an arbitrary value. The Subcommittee accepted that the 90% CI be used and if a more precautionary approach is required then the 1% harvest rate could be lowered.

The Subcommittee noted that no broodstock has been returned to the wild to date and that there may be disease implications associated with transplants.

The Subcommittee noted that collections to date have been predominantly female. The total number of females from any given site must not exceed 50% of the recommended removals. The Subcommittee discussed the lack of protocol for hatchery practices and its implications to mortality, genetic diversity and disease and the subsequent out planting of hatchery reared abalone. It was noted that a genetic paper was reviewed by PSARC which suggested that the number of abalone broodstock used to produce larvae or juveniles for out-planting to the wild should be at least 50 and preferably 100, with equal numbers of males and females, in order to maintain genetic diversity in the enhanced population.

There was also discussion around what the minimum density should be in order to allow collections. It was pointed out that perhaps abalone populations with higher densities should be left alone as they may be more likely to have reproductive success than populations with lower densities.

Conclusions

The Subcommittee recognized that the current culture facilities are in the developmental stage and their culture techniques are still being refined. Consideration of genetics, disease and productivity should be incorporated into the overall program.

The Subcommittee felt that there was a need to limit the number of females being collected at any one site to half the total allowable removals and a minimum of 2 sites over several locations. The Subcommittee found that broodstock collection protocol of 1% of the lower 90% CI of the surveyed available 80 to 120 mm abalone was a conservative approach and if a more precautionary approach is required then the 1% harvest rate could be lowered.

Recommendations

The Subcommittee accepted the paper with revisions.

1. The Subcommittee endorsed the estimate of allowable removals as the lower 90% confidence interval of the 80-120 mm SL density estimate and a 1% removal rate.

2. The Subcommittee recommended acceptance of the survey protocol with the addition that DFO needs to approve the site and transect locations, as well as the number of animals and sex ratio to be removed. It was also recommended that broodstock collections for a project should come from a minimum of 2 sites.

3. The Subcommittee recommended review of the present genetics practices in culture facilities against the previously published papers.

I2002-07: A review of the biology of opal squid (*Loligo opalescens* Berry), and of selected loliginid fisheries

L.C. Walthers and G.E. Gillespie **Accepted subject to revisions**

Rapporteur: Dan Clark

This paper reviews the biology, behaviour and ecology of loliginid squids. It reviews the assessment and management of fisheries for loliginid squid and provides a focus for discussion of current issues relating to B.C. opal squid fisheries. The B.C. opal squid fishery is currently in an undeveloped state, with fewer than 15 licences issued

in each of the last three years, and fewer than five vessels reporting activity in any of those years. The catch is sold as bait or utilized by the catching vessel as bait for other fishing activity. Biological information and stock assessment methods are extremely limited. While some precautionary management measures are currently in place (gear restrictions and permanent area closures), neither of these can address possible overfishing if effort in the fishery increases or market conditions change and a food market is developed.

Opal squid are relatively small (smaller than in California), have low fecundity (10,000 eggs per female), are terminal spawners, and the population size fluctuates widely, presumably influenced by environmental variables. Fishing occurs on spawning aggregations using deck lights, small mesh seines, jigs, and sometimes dip and lampara nets. It is not known if the inability of fishers to repeatedly locate spawning stocks large enough to fish is due to variation in abundance or to differences in spawning distribution between years. The problem of assessing the stock structure and movements results in an inability to predict effects of localized overfishing.

The paper highlighted the following strategies to fishery managers:

1. Status quo. This option entails relatively high risk due to poor quality of data used to monitor the fishery and potential for uncontrolled expansion should market conditions change.
2. Active development and promotion of an opal squid fishery. This would require: development of the food market potential (in competition with other world-wide sources of squid) as opposed to a primary use as bait; development of assessment and management frameworks, and requirements for fiscal support of assessment and management from a fishery association.
3. Status quo with limits to effort increases. This option could maintain potential effort at levels that minimize risk of overharvest and improve fishery-dependent data to monitor the fishery. This option could range from measures to limit increases in fishing power of existing licences, and only allow new licences, if sufficient assessment and management frameworks are developed.
4. Close the fishery. Managers may decide that costs of developing assessment and management frameworks exceed current and/or future economic returns of the fishery.

The Subcommittee also discussed implications of harvesting a forage species and noted that this is a bait fishery, not a fishery for human food, and DFO guidelines rank bait fisheries lower than human food fishery in importance and desirability.

Conclusions

This is an unlimited fishery with no assessment, little management and poor data. The Subcommittee felt that the fishery could be allowed to continue at current levels without an undue conservation risk. Any increase in catch or effort should occur under the New Emerging Fisheries Policy guidelines.

Recognizing the forage fish role of opal squid in the ecosystem, any development of the fishery should take into account the anticipated forage fish policy.

The Subcommittee agreed that the management strategies presented in the paper represent the range of strategies available and that an assessment and management framework would need to be developed depending on the final strategies chosen.

Recommendations

The Subcommittee accepted the paper subject to revisions.

1. The Subcommittee recommended that there should be no increase in effort or landings (for example from the 10 year average of fishing days and the best estimate of catch) in the B.C. opal squid fisheries until stock assessment and management frameworks are developed.

2. The Subcommittee recommended that any development of B.C. opal squid fisheries occur within the context of the New Emerging Fisheries Policy. Any expansion should be through phased development of the fishery and dependent on development of essential fisheries information and assessment and management frameworks.

3. The Subcommittee recommended evaluating the ecosystem impacts of opal squid fisheries and the implications concerning this species as a forage species.

4. The Subcommittee recommended that DFO needs to ensure that log books and fish slip reporting requirements are adhered to in order to improve data quality used in the assessment of the fishery.

Stock Status Reports

Three stock status reports were reviewed and approved by the Subcommittee: Humpback Shrimp, Giant Red Sea Cucumber and Coonstripe Shrimp. Once reviewed and approved these stock status reports will be forwarded to the PSARC Secretariat for publication in the usual manner.

APPENDIX 1: Working Paper Summaries

I2002-01: A Phase '0' review of the biology and fisheries potential of the marine gastropods *Astreaea gibberosa, Euspira lewisii, Fusitriton oegonensis, Nucella lamellosa*, and deep water snails of the family Buccinidae

K.E. Charles and R. Harbo

The marine gastropods under review belong to very diverse groups in not only different families, but in entirely different orders. In all, five groups or species have been selected for review. These are the species *Fusitriton oregonensis, Euspira lewisii, Astraea gibberosa, Nucella lamellosa, Neptunea* spp. and *Buccinum* spp. Of these, snails of the F. Buccinidae are actively fished in the North Atlantic, and have been historically fished in Alaska. A conspecific of the Red Turban, *Astraea gibberosa,* the Wavy Turban Snail, *A.undosa,* is experiencing directed fisheries in Baja California as well as in the State of California. Moon snails, *Euspira lewisii* are only harvested recreationally. There are no accounts of directed fisheries on *Fusitriton oregonensis* or *Nucella lamellosa* or any conspecifics.

A summary of the biology of these five groups has been presented. In some cases, there is so much information that much was left out; in other cases virtually no information is available. A summary of the biological information required to effectively manage these fisheries is presented, as well as recommended studies, prior to development of a fishery.

Toxins in northern marine gastropods are discussed, including symptoms of poisoning, regulating agencies, and toxic species.

A review of active gastropod fisheries of the Pacific United States and British Columbia is presented, with reference to commercial, recreational, and historical aboriginal fisheries. A selection of active gastropod fisheries throughout the world is presented, with particular biological or management problems and solutions highlighted.

Management strategies include area and seasonal closures, size limits, gear restrictions, prohibition of harvest of some species, limited licensing and area licensing, and quotas. There may be biological, habitat, assessment or management reasons why a species may not be a suitable candidate for commercial exploitation.

The authors consider that the costs of collecting the required biological information for stock assessment and developing management strategies may be prohibitive. The consideration of a new gastropod fishery should be considered in a priority setting exercise.

I2002-02: Evaluation of an intensive fishery on Dungeness Crab, Cancer magister, in Fraser Delta, British Columbia

Z. Zhang, W. Hajas, A. Phillips, J.A. Boutillier

The Dungeness crab fishery in British Columbia has been passively managed through sex and size limits. Only male crabs larger than or equal to 155 mm in carapace width may be harvested. The fishery is intensive with exploitation rates well over 90% in the Fraser Delta. The paper attempts to address three specific concerns: (1) is there a recruitment problem? (2) what is the impact of intensive fishing on yield and profit? (3) what scientific criteria could managers use to close the fishery?

To address the first concern, we examined the time-series (1995-2000) data on catch rates for sub-legal crabs. There is no strong evidence that small crabs are becoming less abundant. However, the time-series is short and we (the authors) don't know the recruitment status before the intensive fishing, which has existed for a long time. Thus, it is unknown whether recruitment will increase, if exploitation rate decreases. The impact of intensive fishing on recruitment is yet to be determined.

To address the second concern, we used a length-based and an instar-based models to generate biological reference points to be used for managing the fishery. We calculated yield, revenue and profit per recruit, after some important biological parameters, such as natural mortality rate, vulnerability of different sized crabs to traps, probability of moulting, survival rate for newly moulted crabs, were estimated based on scientific surveys in the Vancouver Harbour. An intensive fishing also results in a great deal of catch-and-release of sub-legal sized crabs. Continuing fishing at a high ratio of sub-legal to legal sized crabs in the catch will result in a net loss in yield in the long-term, as some sub-legal sized crabs will die of handling mortality and could not contribute to the future yield. We conducted analyses on gain-or-loss in yield for continuing fishing at different ratios of sub-legal to legal crabs in the catch to determine threshold points, at which gain is balanced with loss in yield in the long term. To avoid losing yield in the long term, the ratio of sub-legal to legal crabs in the catch should not be allowed to rise above 19:1, 9.5:1, 6.5:1 or 5:1, if the handling mortality rate is, respectively, 5%, 10%, 15%, or 20%.

We provide the following recommendations to the managers based on these analyses:

(1) The current exploitation rate (> 90%) should be reduced to 65-75%. A level of reduction in CPUE relative to the CPUE at the beginning of the fishery could be used to determine when to close the fishery.
(2) A ratio of retained crabs to discards should be used as a means of limiting effort and protecting stocks in conjunction with using CPUE measures, or in fisheries where it is difficult to use CPUE because of protracted moulting seasons or.

(3) Efforts should be made to reduce the negative handling impacts. Tools may include longer soak times, earlier closure of the fishery or adjustment of the fishing season.
(4) Industry, management and science should use these models to assist in assessing the impact of intensive fishing on population dynamics, economic and social benefits for each fishery and in finding optimal management and assessment schemes.

I2002-03: Pandalus hypsinotus, Humpback shrimp: An assessment and management framework for directed fisheries based on results from Drury Inlet Humpback Shrimp Research Program

J.S. Dunham, J.A. Boutillier, D. Rutherford, K. Fong

To develop a biological basis for managing recruitment overfishing in humpback shrimp fisheries, a humpback shrimp population in Drury Inlet was extensively surveyed by Shellfish Stock Assessment (StAD) in November 2001 and March 2002 with trawl and trap fishing gear. Aspects of humpback shrimp biology, including age structure, sex stage changes over time, natural mortality, and fecundity, were studied. Age 1 shrimp constituted 58-66% of the population, age 3 shrimp 3-8% of the population. Approximately 32% of the shrimp were females. Humpback shrimp experienced high natural mortality (M=2.0). Mean fecundity was 880 eggs per female. Larger, older female shrimp typically produced a greater number of eggs than smaller, younger shrimp.

Trap gear, unlike trawl gear, collected proportions of the sexual stages of shrimp that were biased towards larger older females and did not reflect true population proportions. Smaller mesh traps collected more small shrimp (males and transitionals). Trap CPUE estimates derived using age and sex ratios were more variable, and consequently more useful to managers, than CPUE estimates derived using weight.

To manage recruitment overfishing in trawl and trap fisheries using a fixed exploitation rate, tow and trap gear are required to accurately estimate shrimp density and biomass because trap catches in untrawled areas influence overall estimates. Reference Points (RPs), including Target Reference Points (TRPs) and Limit Reference Points (LRPs), were determined for trawl and trap fisheries using fishery independent (based on biomass estimates) and fishery dependent (based on commercial CPUE estimates) data. Constant harvest rates were used to derive the TRPs, the MSY equation used to derive the LRPs. Empirical equations, that are useful for data limited fisheries and were examined in this paper, include biomass dynamic models, Maximum Constant Yield (MCY), and Annual Yield.

To manage recruitment overfishing in a trap fishery using a fixed escapement target, monthly TRPs were derived using the MSY equation; monthly LRPs were derived using shrimp egg production estimates and the natural mortality rate. Results of the

spawner indices indicate that 11-20 female spawners per trap should remain unrecruited to the fishery in March.

Trawl gear by-catch consisted mainly of eelpouts, shiner perch, herring and spiny pink shrimp. Trap gear by-catch consisted of sea stars, red rock crabs, graceful crabs and prawns. Trap by-catch was higher in rocky compared to trawlable areas. Small mesh, compared to large mesh traps, collected higher numbers of by-catch species. Trawl gear not only collected different animals than trap gear, but greater numbers of them as well.

Directed humpback shrimp trawl and trap fisheries presently occur throughout the B.C. coast, in Areas 1, 3, 4, 5, 6, 12, and 13. Recommendations regarding how to manage recruitment overfishing in directed humpback shrimp fisheries using a fixed exploitation rate and a fixed escapement target are provided.

I2002-04: Sea Cucumber quotas based on British Columbia survey data

S. Campagna and C. Hand

The sea cucumber fishery has been managed using precautionary quotas based on conservative estimates of density from surveys conducted in Alaska using a baseline density of 2.5 c/m-sh. Since 1998, seven dive surveys have been conducted in six open fishery areas of B.C. Over 2,500 km of shoreline, or 30% of the area that is designated as commercial has been surveyed. Sufficient data exists to calculate quotas for the commercial fishery from B.C. surveys. Currently 98 PFMAs (Pacific Fisheries Management Areas), or 25% of the shoreline, are open to sea cucumber harvest.

This paper provides survey results and density estimates derived from these survey data sets and are extrapolated to unsurveyed open fishery areas. The parameters and procedures employed in the calculation of the quotas are documented. Mean weights are re-evaluated for all open areas using the market sampling data. New quotas are calculated for all open areas.

Survey results showed that the lower 90%CI of density estimates is higher than the baseline density of 2.5 c/m-sh. Shoreline reduction for the surveys ranged from 0 to 45%, averaging 13%. New estimates of mean weights resulted in a mean weight increase for 56 PFMAs, decrease in 22 PFMAs and 17 PFMAs had no new data, existing mean weight were used.

The authors recommend grouping the PFMAs into three categories to assign density estimates. The surveyed PFMAs are assigned the lower 90% CI of density estimates calculated during the survey. The new baseline density of 5.08 c/m-sh, the minimum of the lower 90% CI of density estimates is recommended for most unsurveyed PFMAs. A third category including PFMAs with exposed shoreline or history of low stock would keep the baseline density of 2.5 c/m-sh. New quotas

would be higher in nearly all Pacific Fisheries Management Areas with the exception of PFMA 13, resulting in an overall increase in quota of 206.8 tonnes coast wide.

I2002-05: Geoduck Stock Assessment Framework in British Columbia

C. Hand

A stock assessment framework for the provision of biomass estimates in a quota-managed geoduck fishery is presented. While quota options are provided to managers for each of the approximate 1,500 geoduck beds on the B.C. coast, there is a high degree of uncertainty in these estimates. This framework was driven by the need to examine the sources of uncertainty in the parameter estimates necessary for biomass calculation and to prioritize data analysis and future data collection for more effective stock assessment.

Through collaboration with resource stakeholders, a large amount of fishery-dependent and fishery-independent data have accumulated, particularly in the last decade. The methods used to collect and analyze data on geoduck density, mean weight and geoduck bed area are described, and the errors, biases and assumptions discussed. Geoduck bed area is identified as the parameter with the most uncertainty and is recommended as the highest priority to resolve. Current methods of extrapolating density estimates to unsurveyed geoduck beds assumes that populations that are closer are more similar than those more distant. It is recommended that more spatially-explicit approaches be used for extrapolation that utilize all of the available information on geo-physical properties of the geoduck bed and the associated characteristics of the populations within them.

I2002-06: Survey protocol for the removal of allowable numbers of northern abalone, *Haliotis kamtschatkana*, from areas in British Columbia for use as broodstock in aquaculture

J. Lessard, A. Campbell, W. Hajas

A survey protocol and methodology to determine abalone abundance has been in use for the last three years. The present paper reviews the data collected during 6 surveys for broodstock purposes and uses these data to determine the appropriate level of removal. The proposed survey protocol and broodstock removal considerations are discussed.

These surveys provided little evidence of recovery of abalone populations. During abalone broodstock collections, more abalone were harvested than was calculated present at several sites.

A precautionary approach is recommended that include using the lower 90% confidence interval of the mean of the mature population estimate (81-120 mm shell length) when calculating the potential number of abalone (*i.e.*, < 1 % of estimated

population) to be removed for broodstock. Abalone is a threatened species and all removal of abalone from the wild should be minimized.

I2002-07: A review of the biology of opal squid (*Loligo opalescens* Berry), and of selected loliginid fisheries

L.C. Walthers and G.E. Gillespie

Opal squid are relatively small, short-lived squids that are found only on the west coast of North America, from Baja California to southeastern Alaska. They are most abundant off California, where they are the basis of a large fishery worth US $20-30 million annually. They live approximately 1 year and are terminal spawners, and the squid are fished while aggregated for mass spawning. The distribution, biology, abundance and ecology of opal squid in British Columbia is not well known, although they have been a minor bait fishery for decades.

Opal squid are particularly difficult to assess and manage because of their short life span. Stock-recruit relationships are weak, and likely driven by environmental conditions. Abundance, distribution and movements not known, in part because opal squid are small and highly motile, evading sampling gear traditionally used in surveys for other species. Age can be determined using statoliths, but it is a time-consuming, specialized process that makes the use of ages in routine assessments too expensive. Protracted spawning and differing growth rates within an annual cohort make use of length-based methods very difficult. The State of California recently spent millions of dollars over three years to develop recommendations for research and assessment and a proposed management plan for the species.

The opal squid fishery in British Columbia is managed through gear restrictions, hail requirements to open areas for fishing and catch monitoring. Number of licences issued, effort and landings have all declined since the mid-1990's, to the point where coast-wide landings data cannot be released publicly because fewer then three vessels submit records. Primary management concerns are quality of catch monitoring, bycatch concerns and adverse impacts of gear on habitat. Opal squid are the last remaining commercial invertebrate fishery that has unlimited licence issue; there are no proactive controls in place to check expansion of the fishery should market demand change.

Several options are suggested to managers: status quo, active development of the fishery (with associated assessment and management frameworks), licence limitation, or complete closure of the fishery in the absence of assessment and management frameworks. Recommendations presented were: the fishery should not be allowed to expand in the absence of assessment and management frameworks, development of the fishery should be in context of the policy for New and Developing Fisheries, and that the ecosystem impacts of fisheries development should be considered.

APPENDIX 2: PSARC Invertebrate Subcommittee Meeting Agenda November 25-28, 2002

Seminar Room, Pacific Biological Station, Nanaimo, B.C.

	25 November **Monday** **Start 1300**	**26 November** **Tuesday** **Start 0900**	**27 November** **Wednesday** **Start 0900**	**28 November** **Thursday** **Start 0900**
AM 1		Introductions and Procedures I2001-06 Survey protocol for the removal of allowable numbers of the northern abalone, *Haliotis kamtschatkana* for broodstock in aquaculture	Introductions and Procedures I2002-04 **Sea cucumber quotas based on B.C. survey data.** **Sea Cucumber SSR**	Previous days unfinished business Rapporteur's Reports Day 3 Finalize committee report.
Break				
AM 2		I2001-05 Geoduck Stock Assessment Framework in B.C.	I2002- 07 A review of the biology of opal squid (*Loligo opalescens* Berry), and of selected loliginid fisheries	**Working Papers for June 2003**
Lunch				
PM 1	**Introductions and Procedures** I2002-02 Evaluation of an Intensive Fishery on Dungeness Crab, *Cancer magister*, in Fraser Delta, B.C.	I2002-01 Phase '0' review of the biology and fisheries potential of marine gastropods and deep water snails.	Coonstripe Shrimp SSR Rapporteur's Reports Day 2	
Break				
PM 2	I2002-03 *Pandalus hypsinotus*, humpback shrimp. **An assessment and management framework for directed Fisheries** **Humpback Shrimp SSR**	Rapporteur's Reports Day 1	Emerging Issues and Committee recommendations	

APPENDIX 3: List of Attendees & Reviewers

Subcommittee Chair: Kim West
PSARC Chair: Al Cass

DFO Participants	Mon.	Tues.	Wed.	Thurs.
* Subcommittee Members				
L. Barton		✓	✓	
J. Boutillier*	✓	✓	✓	✓
B. Bornhold*	✓	✓	✓	✓
D. Bureau		✓		
S. Campagna	✓	✓	✓	✓
A. Campbell*		✓		✓
A. Cass (PSARC Chair)	✓	✓	✓	✓
D. Clark		✓	✓	
L. Convey		✓		
J. Dunham	✓			
K. Fong	✓			
G. Gillespie*	✓		✓	✓pm
W. Hajas	✓	✓		
C. Hand*	✓	✓	✓	✓
R. Harbo*	✓	✓		✓
S. Heizer		✓		
T. Johansson			✓	
B. Koke*	✓			
R. Lauzier*	✓	✓	✓	✓am
J. Lessard	✓	✓	✓	✓am
J. Morrison	✓		✓	
R. Mylchreest*	✓	✓	✓	✓
H. Nguyen	✓			
G. Parker*	✓	✓	✓	
I. Perry*	✓	✓	✓	✓
A. Phillips	✓			
J. Rogers*	✓	✓	✓	✓
D. Rutherford	✓			✓
D. Tzotzos		✓	✓	
B. Waddell	✓	✓	✓	
L. Walthers	✓	✓	✓	
R. Webb	✓			
K. West* (Chair)	✓	✓	✓	✓
E. Wylie		✓	✓	
Z. Zhang	✓			

External Participants:	Mon.	Tues.	Wed.	Thurs.
B. Heath* (B.C. Ministry of Fisheries)		✓		
H. Holmes (Pacific Rim National Park)	✓	✓	✓	

Observers:	Mon.	Tues.	Wed.	Thurs.
T. Norgard (Heiltsuk Fisheries)	✓	✓		
L. Clayton (Pacific Coast Shrimpers Coop.)	✓			
G. Dovey (Underwater Harvesters Assoc.)		✓		
K. Erikson (Pro Quota Group)	✓		✓pm	
G. Krause		✓		
T. Kulchynski (Cowichan Tribes)	✓	✓		
G. LaBoucan (Cowichan Tribes)	✓	✓		
T. Norgard (TNBC Consulting)	✓	✓	✓	
Y. Page		✓		
K. Ridgeway (Pacific Sea Cucumber Assoc.)			✓	
R. Sam (Penelakut Tribe)	✓			
S. Wood (Pacific Sea Cucumber Assoc.)			✓	

Reviewers for the PSARC papers presented at this meeting are listed below, in alphabetical order. Their assistance is invaluable in making the PSARC process work.

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